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EUROPEAN MONETARY UNION AND CAPITAL MARKETS

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MONETARY AND FISCAL POLICY RULES IN THE EUROPEAN ECONOMIC AND MONETARY UNION: A SIMULATION ANALYSIS

Gottfried Haber, Reinhard Neck and
Warwick J. McKibbin

ABSTRACT

Optimal monetary and fiscal policies within the European Economic and Monetary Union (EMU) are determined by simulating a global model under alternative assumptions about the objective function of the European Central Bank (ECB) and about cooperation vs. non-cooperation with fiscal policy-makers. In particular, strategies involving: (a) a money supply target, (b) tracking European inflation, (c) stabilizing European nominal income, and (d) fixing the exchange rate of the Euro with respect to the Dollar are evaluated and compared with respect to the associated welfare effects. The results show the high effectiveness of fixed rules in the presence of supply side shocks and the usefulness of cooperative discretionary measures against demand side shocks. Nominal income targeting by the ECB has to be regarded as inferior to inflation targeting, while fixing the exchange rate leads to quite satisfactory results in most cases.

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1. INTRODUCTION

Since January 1, 1999, the European Economic and Monetary Union (EMU) of eleven member countries of the European Union (EU) has been in effect. National currencies have been replaced by the Euro and will only exist as specific denominations of the Euro until 2002 when Euro notes and coins will become the only legal tender within the EMU. By now, a large body of literature is available on the arguments in favor and against this institutional change and on its possible consequences for European economies (e.g. Kenen, 1995; De Grauwe, 1997; Gros & Thygesen, 1998; Begg et al., 1998; Allsopp & Vines, 1998). Some articles also address the question as to what the loss of monetary sovereignty implies for the design of stabilization policies in Europe.

In Neck et al. (1999), both supply side and demand side shocks of different magnitude are evaluated, and the results suggest that optimal economic policy should consist of fixed rules for supply side shocks, but should be conducted in a more active (discretionary) way for demand side shocks to the economy. Moreover, it is shown that cooperative policymaking within the EMU yields dominant solutions compared to scenarios resembling the European Monetary System I (EMS I) and also dominates the non-cooperative EMU scenarios. Thus, after having identified these strong indications in favor of the EMU and given the historical fact of the existence of the EMU, the next step is to investigate alternative monetary and fiscal policy designs within the EMU, which is done in this paper.

Section 2 presents some theoretical issues concerning the design of macroeconomic policy. The model which is used in this analysis, the McKibbin-Sachs Global Model (MSG2 Model), is briefly described in Section 3. Section 4 explains the simulation and optimization experiments conducted and discusses how they were implemented. In Section 5, selected results from these alternative scenarios are presented, focusing on the supply side shock. Some concluding remarks are given in Section 6.

2. HOW TO DESIGN POLICY RULES?

Both from a theoretical point of view and for practical applications, one of the most challenging questions in economics is how to design macroeconomic policies and policy rules. This question may be divided into three more elementary issues: Are rules better than discretion? Does it make sense to cooperate, or is there something like the "invisible hand" in international economics with strategic policy-makers? If rules are superior to discretion under specific circumstances, which rule should we choose?

The choice of discretionary policies in contrast to fixed rules becomes obvious if the underlying model is of the Keynesian type. In such a framework, optimal discretionary policies (obtained by optimum control methods) are never worse and usually considerably better than the best fixed rule. In addition, cooperative policy outcomes are always at least as good as non-cooperative policy results. If, however, a more neo-classical approach is used, things become less clear, due to the non-causal structure of the dynamic system (forward looking or rational expectations). The optimum control solution then may no longer be time-consistent, which implies that there are strong incentives for the policy-makers to depart from the optimal (discretionary) time path, which in turn is time-inconsistent. Moreover, it can be shown that under specific assumptions, international policy coordination might lead to higher welfare losses when rational policy-makers find it easier to engage in an inflationary monetary expansion. This can be interpreted as a coalition of strategically acting policy-makers against private economic agents (Rogoff, 1985). Hence, we have to conclude that there is no a priori preference for rules or discretion that can be deduced from theory, especially if we confine ourselves to time-consistent solutions of the model used.

The same considerations are valid for the question as to whether cooperation is advantageous or not. It is clear from the theoretical results that cooperative strategies need not be Pareto superior to non-cooperative strategies. Given the Rogoff (1985) results and further simulation exercises, cooperation might even be counterproductive as compared to the non-cooperative case in the sense of "Pareto inferior". On the other hand, Allsopp et al. (1999) stress the importance of fiscal policy coordination in the case of fiscal consolidation (which is a reasonable scenario for the EMU at present) to reduce output losses. However, De Grauwe (1999) is rather critical of this recommendation, stressing instead the importance of monetary policy applied in conjunction with fiscal policies. More recent contributions on policy coordination within the EMU can be found in Hughes Hallett and Mooslechner, 1999.

To sum up, there is much dissent in the literature about the first two questions. Allsopp and Vines (1998), for example, argue in favor of the cooperative approach rather than introducing another player into the dynamic game who even worsens the time-inconsistency problem. Given these diverse results, the present paper deliberately does not rule out any type of policy design a priori, but rather evaluates a broad spectrum of reasonable policy setups for the EMU. Within this framework, appropriate reaction patterns of the

European Central Bank (ECB) to macroeconomic fluctuations have to be developed.

This in turn leads to the third question about the "correct" design of policies and policy rules. Of course, a simple alternative to more complex policy rules would be not to react at all to shocks to the economy. This "no active policy" strategy can be interpreted as the prototype of a tightly fixed and strict rule, which is credible only if there are extremely strong legal obligations or other commitments of the ECB or the fiscal policy-makers which realistically cannot be altered. Other types of strategies proposed in the literature are a money supply target, an inflation rate target, a nominal income target, or an exchange rate target.

Sometimes, money supply targets and inflation targets are compared to each other. This arises almost naturally from the fact that the instrument-target interdependencies are not perfectly clear for monetary policy at all. Moreover, there is no consensus about the question as to whether it is possible for a central bank to track real money supply. In fact, the German example of the pre-EMU Bundesbank teaches us the difficulties of succeeding with monetary targeting, even for widest-sense aggregates like M3 and even for a highly credible central bank. An interesting approach to this issue is taken by Bean (1998), who argues in favor of inflation targets, possibly modified by giving weights to output movements in the case of adverse supply shocks. In principle, the simulations described below are in line with Bean's findings concerning the relative benefits of (especially cooperative) inflation targeting. The inclusion of an output variable for supply side shocks, on the other hand, is somewhat counterintuitive and in contrast to the results described here, as we find that supply side shocks can be treated better by totally fixed rules ("no policy"). Bernanke et al. (1999) find other empirical evidence for the superiority of inflation targeting and recommend this goal as a strategy for the ECB.

Clarida et al. (1998) stress the advantages of inflation targeting as opposed to fixing exchange rates. Again, this is compatible with the results presented below, although exchange rate targeting does not prove to be a particular problematic strategy. On the other hand, Hall and Mankiw (1994) argue that nominal income targeting is a reasonably good rule for the conduct of monetary policy, which is in line with the main recommendations derived from the well-known Taylor rule or the Henderson-McKibbin rule. It will be shown that the stated advantages of a nominal income target cannot be supported by the results of the simulations in the present paper. Bryant et al. (1993) obtain similar results in favor of nominal income targeting using simulation techniques, but report that these results do not necessarily hold for supply side shocks.

As can be seen from these remarks on the large body of literature on this topic, there is still no consensus on what policy design to choose in general, and for the ECB and the fiscal policy-makers of the EMU member countries to choose in particular.

3. THE MCKIBBIN-SACHS GLOBAL MODEL

The McKibbin-Sachs Global Model (MSG2 Model) is a dynamic, intertemporal, general-equilibrium model of a multiregion world economy. It is based on microeconomic foundations by assuming that economic agents maximize intertemporal objective functions. The model exhibits a mixture of classical and Keynesian properties: expectations are assumed to be formed in a rational way, but various rigidities are taken into account by allowing for deviations from fully optimizing behavior. In particular, nominal wages are assumed to adjust slowly in the major industrial economies (except for Japan); due to this wage stickiness, extended periods of unemployment can be present in these economies. Nevertheless, the model solves for a full intertemporal equilibrium in which agents have rational expectations of future variables. As a model with theoretically constrained long-run properties, it can display how the short-run adjustment of the world economy to exogenous shocks depends upon the long-run adjustment.

The theoretical structure of the model as well as a listing of its equations are given in McKibbin and Sachs (1991) and additional documentation can be found on the Internet at http://www.msgpl.com.au/; here only those theoretical features are pointed out which make it particularly well suited for analyzing adjustments to exogenous shocks. First, the long run of the world economy is well determined, being driven by a neoclassical growth model, with exogenous technical progress and population growth. In the short run, on the other hand, the dynamics of the global economy towards this growth path is determined both by Keynesian rigidities in the goods and labor markets and by optimal decisions, conditional on expected future paths of the world economy. Thus, the model takes into account both theoretical considerations of long-run effects of shocks and short-run dynamics towards these long-run outcomes based on historical experience, with expectations formation providing a link between the long-run outcome and the short-run adjustment.

Secondly, the MSG2 Model is a fully specified dynamic general-equilibrium model incorporating both the demand and the supply sides of the major industrial economies. Stock-flow relations are carefully observed, and intertemporal budget constraints are imposed. Intertemporal budget constraints and forward-looking expectations require that all outstanding stocks of assets must be ultimately serviced. The underlying growth of Harrod-neutral productivity plus growth in the labor force is assumed to be 2.5% for each region. Given the long-run properties of the model, the world economy settles down to the 2.5% steady-state growth path after any set of initial disturbances.

Thirdly, asset markets are efficient as asset prices are determined by intertemporal arbitrage conditions and rational expectations. Asset prices are tied down by the imposition of intertemporal budget constraints. The long-run behavior of the model depends on stock equilibrium rather than flow equilibrium. Asset prices stabilize in real terms, once the desired ratios of asset stocks to GDP are reached. The short run of the model behaves in a similar way to the basic Mundell-Fleming model under flexible exchange rates and high capital mobility; however, the future paths of the world economy are important in the short run because of the forward-looking behavior in asset and goods markets. The assumptions of rational expectations in financial markets and of partially forward-looking behavior in real spending decisions allow for the incorporation of the effects of anticipated policy changes. As a consequence, every simulation requires that the entire future sequence of anticipated policies must be specified.

Finally, the supply side of the model is specified in an internally consistent manner. Factor input decisions are based in part on intertemporal profit maximization by firms. Labor and intermediate inputs are determined to maximize short-run profits, given a stock of capital that is fixed within each period and adjusted according to a Tobin's q-model of investment, where Tobin's q evolves according to a rational-expectations forecast of future after-tax profitability. The wage-price dynamics, on the other hand, is specified on the basis of empirical evidence concerning differences in the wage-price processes in the United States and Europe on the one hand and Japan on the other, resulting in different degrees of wage and price stickiness in these regions.

The version of the MSG2 Model used in this paper, called MSGR44A, consists of models of the following countries and regions: the United States, Japan, Germany, the United Kingdom, France, Italy, Austria, the rest of the former European Monetary System (REMS), the rest of the OECD (ROECD), Central and Eastern European economies (CEE), non-oil developing countries, oil-exporting countries, and the former Soviet Union. For the last three regions, only foreign trade and external financial aspects are modeled, whereas the industrial countries and regions are fully modeled with an internal macroeconomic structure. Although the basic theoretical structure for all industrial regions is the same, institutional differences are taken into account, especially in modeling labor markets.

In contrast to macroeconometric world models, the MSG2 Model is fitted to macroeconomic data by a mix of calibration techniques for computable general-equilibrium models and econometric time-series estimates. Behavioral parameters taken from econometric studies and data (for 1992) for macro aggregates were combined with steady-state relations in the model to generate other data. The year 1992, for which actual data were replicated, is not regarded as representing a steady state of the model but a point on the stable adjustment path towards the steady state, hence not all steady-state relations are assumed to hold for that year. The model is solved in linearized form, with the linearization taking place at a point in time (1992, in our case) instead of along some reference path. The baseline is updated to 1997.

For the simulations and optimizations described in this paper, several modifications of the original MSG2 Model became necessary. In contrast to previous applications of the model, only scenarios within the framework of the EMU are analyzed. Thus, the United Kingdom had to be eliminated from the European Monetary System I (EMS I) group of countries, allowing for a considerable amount of exchange rate floating between the British Pound and the Euro.

As the main focus lies on optimal policies within the EMU, the implementation of the European System of Central Banks (ESCB) is the most important update of the model structure. As there is no joint monetary aggregate for the Euro zone in the MSG2 Model, the EMU has been modeled by implementing exact exchange rate pegging for all EMU member countries to the German currency which is considered the anchor currency of the EMU. Note that this assumption does not involve any loss of generality and that any other currency might have been chosen as well without altering the simulation and optimization results. As a consequence, Germany is no longer able to influence the domestic money supply; this instrument is now controlled by the ECB as a proxy for the whole ESCB. Thus, money supply in all EMU member countries is not available as an instrument any more, but monetary policy is conducted by the ECB, which acts independently of the instruments and goals of national fiscal policies.

4. SIMULATION LAYOUT

In this section, the simulation layout is described in detail. In the simulation experiments, some exogenous shocks are imposed under different assumptions regarding economic policy arrangements in Europe. The aim is to analyze the reactions of the European economies to these shocks. Here, we describe the assumptions made about the baseline solution of the model, the objective function used to evaluate different outcomes, assumptions and solution concepts used in the analysis, the European policy scenarios analyzed, and the shocks acting upon the model economies.

4.1. *Baseline Solution*

First, a baseline solution of the dynamic model has to be calculated. This baseline solution can be seen as a stable adjustment path towards the long-run growth path of the model. Therefore, there are good reasons to interpret this baseline solution as an optimal path of the economy. When calculating this baseline of the model, the exogenous variables (in the broadest sense, including the instrument variables) are kept at constant values or constant growth rates. This projection serves as a benchmark for the economic performance of each policy-maker and for the world economy as a whole. The next step is to simulate different shocks to the exogenous variables and to analyze the time paths of selected key variables.

4.2. *Objective Function*

To compare the welfare effects of different policy actions for one or several countries, a single measure of economic performance is needed for each of these countries. Such a measure can be the intertemporal welfare losses due to the simulated shock. To calculate these welfare losses, an objective function has to be specified. For computational ease, an additively separable quadratic welfare loss function has been chosen. The welfare losses Ω_t in each period t are equal to the sums of the weighted (λ_i) quadratic differences between the actual values τ_i and the optimal values τ_i^* for each of the i target variables:

$$\Omega = \sum_{t=1}^{T} (1+r)^{-t}\Omega_t,\ \Omega_t = \sum_{i} \lambda_i(\tau_i - \tau_i^*)^2 \tag{1}$$

In order to take into account the dynamic structure of the overall welfare losses, the welfare losses in each period have to be discounted to their present values (using the rate of time preference of the government r, which is assumed to be 10%) and to be summed up over the time horizon T (100 years in the simulations, from 2001 to 2100) to obtain the total welfare loss.

For the countries for which a welfare loss (objective) function is specified (Germany, France, Italy, Austria, and the REMS), the target variables in the following simulations are inflation, real GDP, the current account and the budget deficit. For the present purpose, all target weights are set equal to 0.25 in the base simulations, producing an equally weighted objective function which is standardized as the weights add up to 1. As mentioned above, the baseline values of the target variables are considered as their optimal values. Note that this implies that the welfare losses in the baseline scenario have to be zero, which is another reason for using this baseline as a benchmark for all simulations.

4.3. *Basic Assumptions and Solution Concepts*

For the scenarios without active macroeconomic policy, it is assumed that the instrument variables of the policy-makers in all countries are set at the same values as in the baseline solution ("no-policy" or fixed-policy simulations). In this case, the calculation of the welfare effects is straightforward: First, the dynamic model is solved subject to the exogenous shock. Then, the values of the objective functions are calculated.

In the simulations with dynamic optimization, the fiscal policy-makers of the member countries of the EMU are considered as players in a dynamic game, namely Germany, France, Italy, Austria and REMS (which is considered as a single country block in this paper). The players set the values of their respective instrument variables in each period. In the "non-cooperative" cases, they do so by minimizing their welfare loss functions subject to the dynamic model and given the optimizing behavior of the other players. This leads to a Nash-Cournot equilibrium of the dynamic game. In the "cooperative" cases, a joint welfare loss function, which is a weighted sum of the individual objective functions, is minimized subject to the dynamic model. This is equivalent to assuming a European dictator who minimizes overall welfare losses of the players involved, and can be interpreted as the result of an agreement between the policy-makers of the five countries. It corresponds to the collusive solution in game theory, because all players have equal weights in the joint objective function. Variations of these weights were tried, but gave qualitatively similar results.

In some of the simulations, the ECB is modeled as a separate player in the dynamic game and is assigned a specific target (European inflation or European nominal income), depending on the particular scenario. In other simulations, the money supply target is fixed as an exogenous variable or the exchange rate to the U.S. Dollar is fixed by inverting some model equations. Note that for the last two targets, the ECB is always able to reach its objectives exactly, as the monetary policy reaction is "hard-coded" in the model equations. In the case of inflation targeting and nominal income targeting, the ECB is implemented as a separate player and always succeeds in the non-cooperative case, as this can be seen as a fixed instrument setup, where the number of instruments (only European money supply) exactly equals the number of objective variables (only either European inflation or European nominal income). Hence all deviations in the target variable are phased out by appropriate variations of the single instrument. In the non-cooperative case, this assignment of instruments to target variables is no longer valid, and an overall objective function is calculated for all players together.

When the ECB is modeled as a player, it receives the same weight in the objective function as the five other players together, which leads to a weight of five for the ECB and one each for Germany, France, Italy, Austria and REMS. The results presented in this paper and further sensitivity analyses show that the weight attached to the ECB is large enough to ensure that the ECB targets can be reached in the cooperative cases, too, and that variations in the cooperative weights between the ECB and the EMU member countries do not lead to significant differences in the results.

In the cooperative solutions, not only the national fiscal policy-makers cooperate, but the ECB also pursues the joint objective function (which is, of course, also the case for the fiscal policy-makers, who now take the ECB target into account). Consequently, in the non-cooperative optimizations there is neither cooperation among the national fiscal policy-makers nor between the ECB and the fiscal policy-makers of the member countries. This fits systematically well into the underlying concepts of cooperation and has to be taken into account for the interpretation of the results.

All European objective variables are calculated as weighted averages of the respective country-specific values. Although it can be shown that the results of the simulations and optimizations do not strongly depend on the selection of the weights, empirical figures derived from GDP (at market prices) have been chosen. The weight for the REMS is calculated as the residual of the other four countries modeled with respect to the EMU aggregate GDP (based upon the sum of the eleven member countries). The exact figures can be seen in Table 1.

The MSG2 Model assumes rational expectations for private-sector agents; hence, some complications arise for the resulting dynamic games. Either the entire future paths of all instrument variables (open-loop policy) or a policy rule for the instrument variables could be calculated (closed-loop policy) as a solution for the dynamic game. Here, the problem of time-inconsistency has to be taken into account. Time-inconsistency means that at a future time point, re-optimization results in time paths for the instruments which are different from

Table 1. Weights for European Aggregates in the Objective Function.

Country/Region	GDP 1998 at Market Prices [millions ECU]	Weight
EMU (EU-11)	5,863,995	
Germany	1,921,764	0.3277
Austria	188,435	0.0322
France	1,297,401	0.2212
Italy	1,058,697	0.1805
REMS	1,397,680	0.2384

Source: Eurostat.

the optimal open-loop policy. The presence of forward-looking private agents can be interpreted as the presence of another (implicit) player in the dynamic game. Therefore, the solution of a standard optimum control problem may not be carried out.

The solution algorithm DYNGAME, which is used to solve the MSG2 Model, calculates strongly time-consistent, closed-loop policy rules; hence its solutions do not suffer from the time-inconsistency problem. This has to be kept in mind when interpreting the results of the dynamic simulations involving strategic policy optimization: when optimization by one or more players is assumed, time-consistent (credible) optimal policies are calculated, which may be inferior to unconstrained (but time-inconsistent) optimal policies.

In order to explore the effects of alternative monetary regimes and fiscal policy arrangements, it is necessary to model the monetary and fiscal policy interactions in Europe explicitly. Because of the focus of this paper on European policies, the other countries contained in the MSG2 Model are not regarded as strategic players. In particular, it is assumed that the USA, Japan, ROECD, the U.K. (which is assumed to remain outside the EMS and EMU), and CEE keep the values of their instrument variables (money supply and government expenditures) at the respective baseline values in all simulations. This means that they do not react to either the exogenous shocks or the policy response of European countries to these shocks. It is not pretended that this assumption is a realistic forecast about what might be done by the policy-makers of these countries; instead, it is made in the present context in order to isolate the effects of alternative European policies on macroeconomic variables.

Table 2. Overview of Policy Scenarios.

		Fiscal Policy (EMU Member Countries, National)	
		Non-Cooperative	Cooperative
Reference Scenario (No Policy)		Scenario 0	
Monetary Policy (ECB)	Monetary Targeting	Scenario 1N	Scenario 1C
	Inflation Targeting	Scenario 2N	Scenario 2C
	Nominal Income Targeting	Scenario 3N	Scenario 3C
	Exchange Rate Targeting	Scenario 4N	Scenario 4C

4.4. Policy Scenarios

For all exogenous shocks investigated, five main scenarios have been simulated. For all but the fixed policy scenario (labeled 0), both a non-cooperative and a cooperative solution are calculated. The main scenarios are numbered 0 to 4, while the suffix "N" denotes the non-cooperative case and "C" denotes the cooperative solution. See Table 2 for an overview.

First, in Scenario 0 ("No-Policy Scenario"), a "no-policy" solution is determined, where the values of all instruments (European money supply and national public consumption in the EMU member countries) are kept at baseline values. This corresponds to completely fixed rules, which can be regarded as implementable only as long as they are completely credible to the private economic subjects and the other policy-makers.

Scenario 1 ("Monetary Targeting") introduces a fixed monetary rule for the ECB (constant growth of the European money supply by 2.5% per year) and active (optimal discretionary) fiscal policy (public consumption) by the EMU member countries. This strategy is similar to the monetary policy conducted by the Bundesbank in the past (and by some other European central banks, such as the Swiss central bank) with strong emphasis on constant and moderate growth of money supply. Actual policy measures of the ECB indicate that this setup may also be seen as a first approximation for the present interventions and the underlying strategy of the ECB.

In Scenario 2 ("Inflation Targeting"), the ECB minimizes fluctuations in the European inflation rate, where we use GDP shares of the respective member countries as weights for calculating the overall inflation rate within the Euro zone (see above). Note that this is nearly equivalent to fixing the inflation rate deviations from the baseline run of the model to zero, even in the cooperative simulations, and that the regional (national) inflation rates do not show much divergence among the EMU member countries in the simulations. This kind of policy paradigm is well known from central banks of Sweden and the United Kingdom. As there is no clear commitment to a specific strategy by the ECB, this setup might possibly be a realistic alternative to inflation targeting for modeling the "real" European monetary strategy.

Scenario 3 ("Nominal Income Targeting") introduces another target for the ECB: instead of aiming at stability of core monetary indicators, weighted European (EMU) nominal income is the single objective variable of the ECB. This scenario contains both monetary and real objectives of the ECB and resembles the main elements of the Taylor rule or the Henderson-McKibbin rule.

In Scenario 4 ("Exchange Rate Targeting"), the ECB fixes the Euro exchange rate against the U.S. Dollar by unilateral pegging. Of course, a managed floating implementation could be used for this scenario as well, but the differences are quantitatively negligible. Moreover, the problem of specifying the bandwidth of the managed float and the speed and "smoothness" of reaction would introduce additional arbitrary elements into the simulations. The exchange rate targeting strategy has been postulated primarily by some European politicians (e.g. the former German Minister of Finance, Lafontaine) in the light of the permanent depreciation of the Euro since the beginning of the monetary union in January, 1999; at present, it is not a realistic option for the ECB.

4.5. Shocks

Several exogenous shocks were imposed on the model. Here in particular, temporary negative productivity shocks and temporary negative demand shocks are considered, which may be country-specific (affecting only Germany, in the present case), regional (affecting the EMU countries), or global (affecting all countries modeled explicitly). The discussion in Section 5 focuses mainly on the European productivity shock.

A productivity shock can be interpreted as a temporary inward shift of the production possibility frontiers of all countries. It may be caused, for example, by an environmental catastrophe resulting in a reduction of the supply of intermediate goods required for producing industrial goods, or by another exogenous reduction in total factor productivity. In particular, total factor productivity is assumed to fall by 4% the first year (2001, in our simulation), 3% in the second year (2002), 2% in the third year (2003), and 1% in the fourth year (2004) as compared to the baseline of the model. The reactions of key macroeconomic variables on such a productivity shock under alternative assumptions about monetary and fiscal policy arrangements are the subject of the next section.

From elementary macroeconomic theory, it is well known that supply shocks and demand shocks have different effects on output, the price level and other aggregate variables. Therefore, in addition to negative productivity shocks shifting the aggregate supply curve to the left, we also consider negative demand shocks shifting the aggregate demand curve to the left. In particular, we simulate the consequences of a temporary exogenous decrease of real private consumption, which might be due to pessimistic expectations or changed preferences, for example. In these simulations, autonomous real private consumption is assumed to fall by 6% in the first year (2001), 4.5% in the second, 3% in the third, and 1.5% in the fourth year as compared to the baseline of the model. Again, the country-specific (Germany), the regional (EMU) and the global variant of this shock are simulated for all five main policy scenarios.

5. RESULTS

5.1. The European Supply (Productivity) Shock

Here, the response of the European and other economies to the European-wide negative temporary productivity shock is summarized (see Fig. 1). In Europe, this is generally characterized by the typical effects of a negative supply shock: the aggregate supply curve shifts to the left (upwards), implying lower real GDP and a higher price level in a static or lower real growth and higher inflation in a dynamic context. This pattern prevails in all scenarios considered; different macroeconomic policy arrangements, however, lead to different outcomes in terms of output versus inflation losses and of the intertemporal as well as the international distribution of the stagflationary burden.

In particular, in Scenario 0 ("no-policy" rules, i.e. fixed rules for monetary and fiscal policies), real GDP falls by about 2% in the European countries directly affected during the first two years of the shock and returns to its baseline level after five years. Inflation increases by about 2 percentage points in the first year and returns more quickly to its baseline values. Spillovers to the U.K. are greater than to the U.S. and to Japan and are small in general (less than 0.5% of GDP and the price level). Welfare losses (deteriorations of the values of the objective functions as described in the previous section) are distributed ements are the subject of

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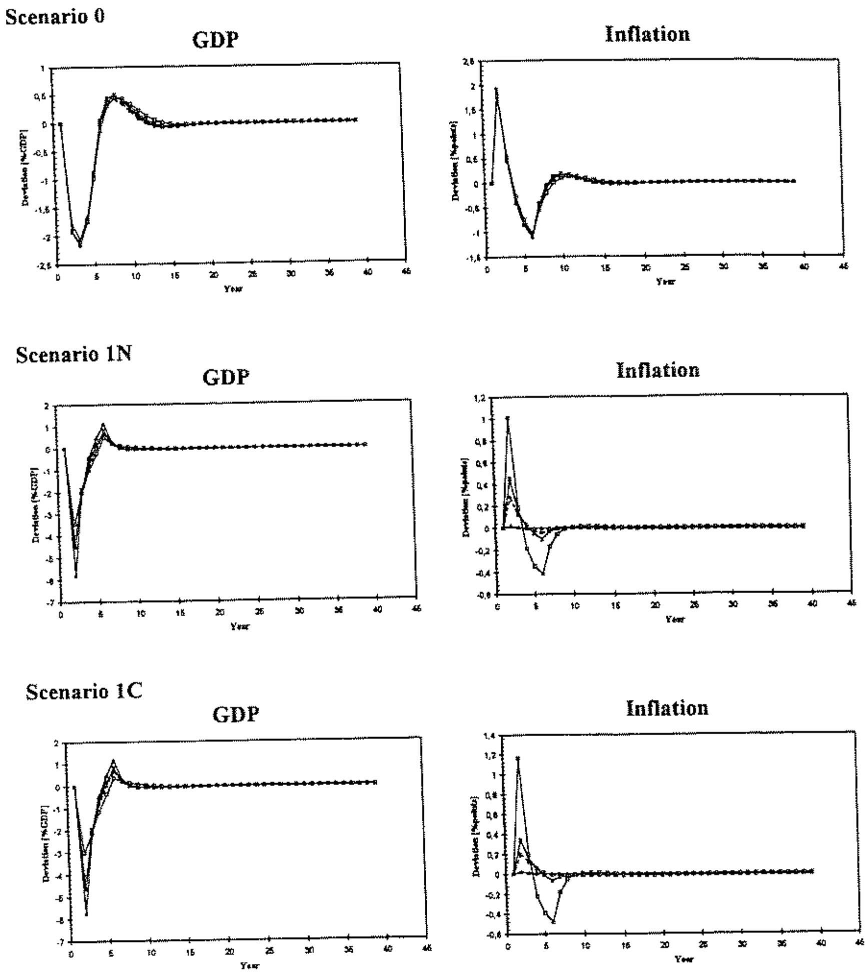
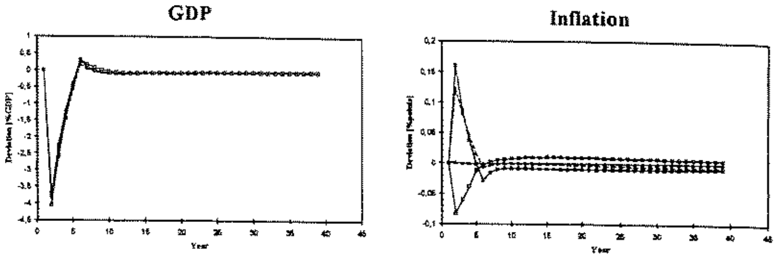


Fig. 1. Reactions of GDP and Inflation on European-wide Negative Supply (Productivity) Shock.

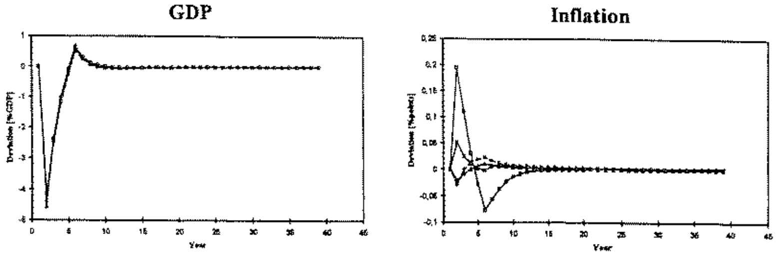
All values are deviations from baseline values; for GDP: percent of baseline GDP; for inflation: percentage points.

—□— Germany —▲— Austria —✕— France —O— Italy

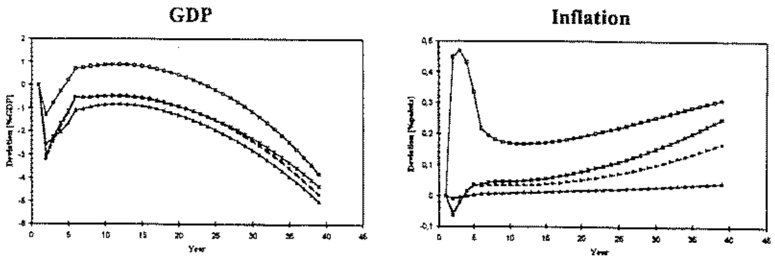
Scenario 2N



Scenario 2C



Scenario 3N



Scenario 3C

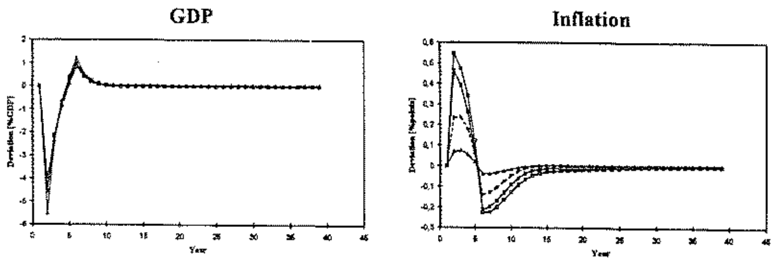
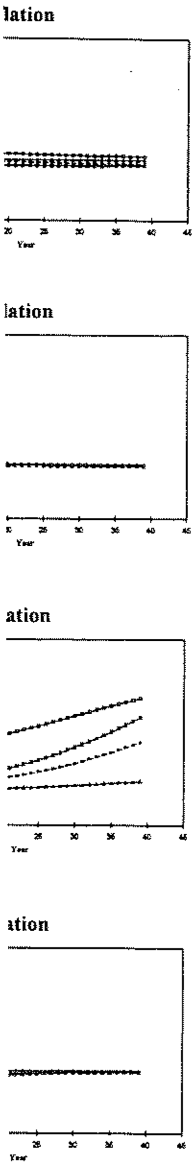


Fig. 1. Continued.



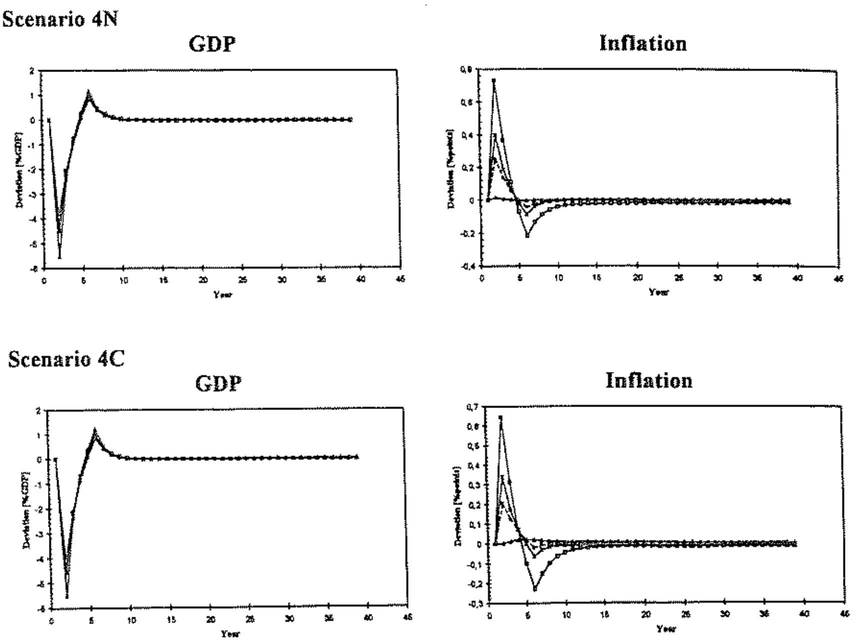


Fig. 1. Continued.

approximately equally between the five European countries considered; over time, they fall from the first period to near zero from period seven (2007) onward. Inflation and GDP losses contribute in approximately equal amounts to the welfare losses in all countries affected.

Scenario 1N (monetary targeting, non-cooperative fiscal policies) implies restrictive fiscal policies in the countries directly affected by the shock, especially in the first period, directed at reducing inflation. In later years, fiscal policies become more expansionary. Real GDP falls by 3 to 6% in the first year, but returns to baseline levels faster than in Scenario 0. The rise of inflation is distinctly weaker (less than 1 percentage point) than in Scenario 0. Welfare losses are higher than in Scenario 0 in all countries. The results can be interpreted to mean that under the objective function specified for the European countries, the target of price stability has priority over the output target; the price stability target calls for a restrictive demand management in a similar way to the current account and the budget deficit targets. However, in Scenario 1N only fiscal policies are available to combat inflation, which might be considered to be an inefficient assignment of instruments to targets. Fiscal cooperation combined with monetary targeting (Scenario 1C) looks very similar to the non-cooperative case.

In Scenario 2N, the ECB acts in a restrictive way and brings European inflation exactly to its baseline values. Inflation rates in different EMU countries are not exactly equal to their baseline values, but very close to them. Government expenditures, on the other hand, are more expansionary than in the previous scenarios, resulting in an inefficient game of fiscal policy-makers against the ECB (and against each others). GDP behaves in a similar way to before.

Cooperative inflation targeting (Scenario 2C) again gives different results. Here the ECB targets European inflation, and fiscal policy-makers behave in a cooperative discretionary way. Now the ECB acts in a slightly less restrictive way than in the previous (non-cooperative inflation targeting, 2N) scenario, but also brings European inflation close to its baseline values nevertheless. Government expenditures are now lower than in the baseline solution, hence fiscal policies support the restrictive monetary policy of the ECB. Rates of inflation fluctuate a little bit more than in the non-cooperative case, especially in Germany, but always by less than 0.2 percentage points. Welfare losses are significantly lower than in Scenario 2N.

Very poor results can be observed in Scenario 3N (non-cooperative nominal income targeting), where overall welfare losses amount to approximately six times the values observed in Scenario 2C. There are strong indications for an inefficient game between the fiscal policy-makers and the ECB. Government consumption is expansionary at the beginning of the simulation and tends towards the baseline after the first period. After a few more years, however, fiscal policies for some countries become more expansionary again while other EMU members implement highly restrictive policy measures. The money supply figures also show signs of a lack of stability. This scenario produces the worst outcome for all magnitudes of the imposed productivity shock.

Although cooperation provides generally better results and the welfare losses are cut by half in Scenario 3C (cooperative nominal income targeting) as compared to the previous simulation, the welfare figures are still unsatisfactory for the productivity shock. Nominal income targeting does not seem to be an effective strategy for coping with supply side shocks at all.

A completely different picture arises from exchange rate targeting (4N and 4C). Both money supply and government expenditures are reduced relative to the baseline solution. As for money supply targeting, the differences between the non-cooperative and the cooperative optimizations are quantitatively small.

5.2. *Effects of other Shocks*

For the negative demand shock (exogenous reduction of private consumption), effects on GDP are comparable to those of the productivity shock, whereas inflation is reduced by the drop in private consumption. Fiscal policies and, to some extent, monetary policies as well mostly react to this in an expansionary way, but again there is a variety of policy reaction patterns depending on the nature of the shock and on the scenario assumptions. Lack of space precludes a more detailed presentation of the results, which will be given elsewhere. The most important effects for our purpose are the welfare rankings under the negative demand shock, which will be described in the next section.

5.3. *Welfare Effects of Different Scenarios*

Table 3 summarizes the welfare results of all 54 simulations performed for this paper. For each of the six different shocks, a ranking of the nine scenarios can be seen in the columns.

For the productivity shock, it can easily be seen that the "No Policy" scenario (0) always produces the best outcomes and that the non-cooperative nominal income targeting (scenario 3N) is always by far the worst. Cooperative nominal income targeting (3C) and non-cooperative inflation targeting (2N) cannot be recommended in the case of a productivity shock either, although they yield significantly better results than non-cooperative nominal income targeting (3N). Quantitatively comparable results arise from cooperative inflation targeting (2C) and cooperative exchange rate targeting (4C): if the shock is limited to Europe, inflation targeting (2C) is slightly better; for the worldwide and Germany-specific shocks, exchange rate targeting (4C) is marginally superior.

Another interesting aspect of the productivity shock is the fact that the differences between the cooperative and the non-cooperative solutions are less for exchange rate targeting (4N and 4C) than for inflation targeting (2N and 2C). Thus, if cooperation is difficult to achieve, it might be useful to aim at the foreign exchange target.

These recommendations do not hold any longer when we consider demand shocks. First of all, note that in this case cooperative inflation targeting (2C) is significantly better than the fixed policy scenario (0) and may be regarded as the best solution (except for the asymmetric demand shock hitting Germany, where this alternative is slightly beaten by cooperative nominal income targeting). While cooperative nominal income targeting (3C) produces acceptable results for the demand shock and might represent a not too bad "midfield" response to distortions originating from the demand side, the practical choice between cooperative inflation targeting (2C) and cooperative exchange rate targeting (4C) is easy: cooperative inflation targeting is always superior.

With respect to cooperation vs. non-cooperation, out of 24 cases cooperation is superior in 21 cases. Exceptions only occur for the European productivity shock with exchange rate targeting (4N and 4C; the results can be regarded as nearly equal in terms of the values of the objective function) and for the monetary target (1N and 1C) when imposing the European and worldwide demand shocks (again, the differences are relatively small for the symmetric European shock). Thus, there seems to be fairly strong evidence in favor of

Table 3. Welfare Results of Different Scenarios.

OF: Sum of values of objective functions for Germany, France, Italy, Austria and REMS. Ranking: 1 is best, 9 is worst

Scenario		Supply (Productivity) Europe	Supply (Productivity) World	Supply (Productivity) Germany	Demand Europe	Demand World	Demand Germany
0	OF	21.1	27.0	4.5	38.2	48.7	32.1
Reference	Rank	1	1	1	6	7	8
1N	OF	34.1	46.8	5.9	27.1	49.0	25.1
Money	Rank	6	6	5	2	8	7
1C	OF	34.0	46.4	5.6	28.5	60.0	12.4
Money	Rank	5	5	3	5	9	3
2N	OF	41.4	53.5	18.1	28.1	35.6	20.8
Inflation	Rank	7	7	8	3	5	6
2C	OF	31.4	40.2	6.6	22.7	14.45	12.3
Inflation	Rank	2	4	6	1	1	2
3N	OF	175.8	244.3	36.5	127.7	36.7	34.2
Income	Rank	9	9	9	9	6	9
3C	OF	88.1	129.2	13.0	28.2	30.5	11.2
Income	Rank	8	8	7	4	4	1
4N	OF	32.8	38.0	5.6	74.7	17.6	13.8
Ex. Rate	Rank	3	3	3	8	3	5
4C	OF	32.9	37.8	5.0	74.3	16.2	13.0
Ex. Rate	Rank	4	2	2	7	2	4

cooperation and against non-cooperation, regardless of the type of shock and the monetary strategy adopted by the ECB, as long as we do not observe a worldwide demand shock in combination with a money supply target.

Another lesson that can be learnt from the simulation results arises from the fact that there might be information problems on the nature of a shock, e.g. due to information lags. Therefore, there might be uncertainty about the monetary policy strategy to use. Another reason why it might be important to identify "robust" objectives for the ECB is the difficulties of changing the monetary regime (credibility issues, implementation obstacles). So the question might be which strategy to choose if the ECB is essentially "blindfolded" and has to stick to a chosen strategy at least for a reasonably long time. Admittedly, every analysis that does not take into account the probabilities of the occurrence of different shocks and the detection probabilities must remain preliminary and incomplete. Nevertheless, without quantitative proof, the figures calculated in this paper may be interpreted as preliminary evidence to support the choice of cooperative inflation targeting (2C) under such circumstances, as this is a rather robust strategy. Of course, this can only be seen as a first hint in that direction.

6. CONCLUDING REMARKS

In this paper, we investigated how fiscal and, in particular, monetary policies should be designed within the context of the EMU. The main questions were whether stabilization policies should be conducted in a discretionary way or according to fixed rules, whether cooperation among policy-makers and/or the ECB might give better outcomes than a non-cooperative framework, and which objective variable the ECB should target.

First, the rules vs. discretion question can be answered clearly: the choice depends strongly on the type of shock the policy-maker has to face. In the case of a supply side shock (e.g. the productivity shock used in this paper), credible fixed rules ("no [active] policy solutions") may be a better response than active time-consistent policies. Exactly the opposite is true for a negative demand shock, where fixed rules generally produce undesirable results. This supports results obtained from previous simulations (Neck et al., 1999) and should be further evaluated using alternative models of the world economy. If these findings can be confirmed under more general conditions, the long-lasting controversy between advocates of demand-side and supply-side policies may be given an intuitive (though not easily testable) solution: if shocks arise from the demand side, activist interventions are preferable; if they occur on the supply side, rule-based policies might dominate even cooperative discretionary policy strategies.

Second, we find strong evidence in favor of cooperation vs. non-cooperative institutional arrangements, even if we place strong emphasis on the objective variable of the ECB, and therefore assign higher priority to the common monetary target than to the individual national fiscal targets of the EMU member countries.

Third, it is not easy to recommend a single target for the ECB, as this, of course, also depends crucially on the nature of the shock. In contrast to some other literature on monetary policy design, we do not find evidence that nominal income targeting might be systematically preferable to the other strategies considered. If an "all purpose" strategy has to be selected, the figures may be carefully interpreted to support cooperative inflation rate targeting.

Further research concerning the robustness of these conclusions (including other types of models) are desirable in order to corroborate (or perhaps falsify) our findings. This will be subject to future analyses.

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